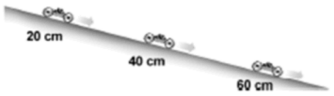
2.1 Using a Scientific Model to Predict Speed

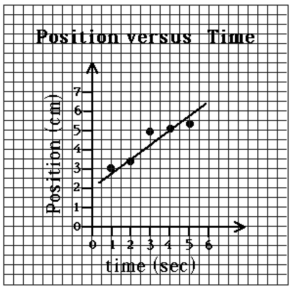
Key Question:
Can you predict the speed of the car at any point on the ramp?



Distance	Speed
20 cm	?
40 cm	?
60 cm	?

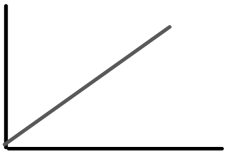
One use for graphs is to "predict" data that is not measured on the graph. The slope of the line graph can predict results or find a relationship between the MV and RV

Extrapolate: extending the graph, along the same slope, above or below measured data.
Interpolate: predicting data between two measured points on the graph.



time (s)	position (cm)
1	3.0
2	3.4
3	4.8
4	5.0
5	5.3

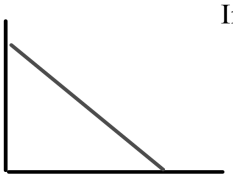
In science you don't always connect the dots, Scientists use a "best-fit" line that shows the trend in the data



Patterns in graphs

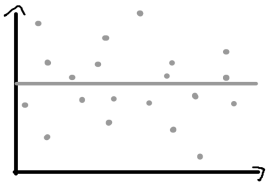
Direct Relationship:

- As the x variable gets larger the y variable also gets larger, if the x variable gets smaller so does the y variable



Indirect Relationship:

- As the x variable gets larger the y variable gets smaller, if the x variable gets smaller the y variable gets larger. "Teeter Totter"



If there is no pattern between the variables we say they have a "Null" relationship

You can use this website to make graphs for labs
Google CREATE A GRAPH

http://nces.ed.gov/nceskids/createagraph/default.aspx

Question: How does location on the ramp affect the speed of the car?

MV:
RV:

Materials: Ramp, car, photogate, weights

What will we need to control in this experiment?

Lab 2.1 Parts 3 and 4
Use your graph to predict the speed of the car at 2 locations you DID NOT already test down the ramp
Do a test to compare your predictions to the observed values. Record your observations in section 3 of lab 2.1

Part 4- Compare your observations to your predictions and calculate the error

Word	Definition	Example or Illustration
• Extrapolate	**Predictions made outside of a set of observations**	
• Interpolate	**Predictions made between known observations**	

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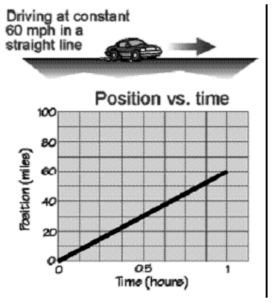
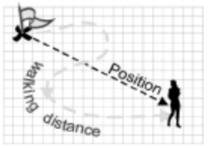
2.2 Position and Time

Key Question:
How do you model the motion of the car?



2.2 Position and Time

- Position- comparison from starting point, includes direction
- Distance- interval of length without regard to direction

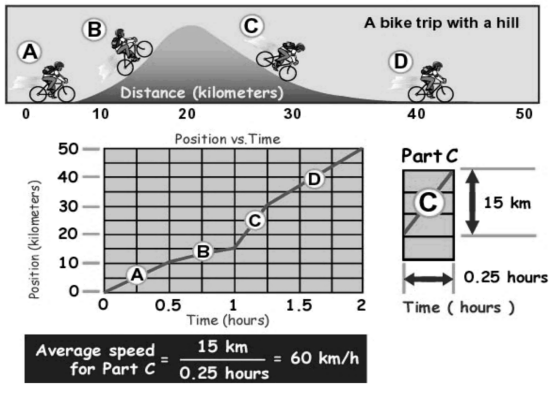


2.1 Scientific Models

Copy and define the following vocabulary words. You may need to use your textbook and a dictionary.

- Direct Relationship
- Indirect Relationship
- Null Relationship

Position vs.Time Graph

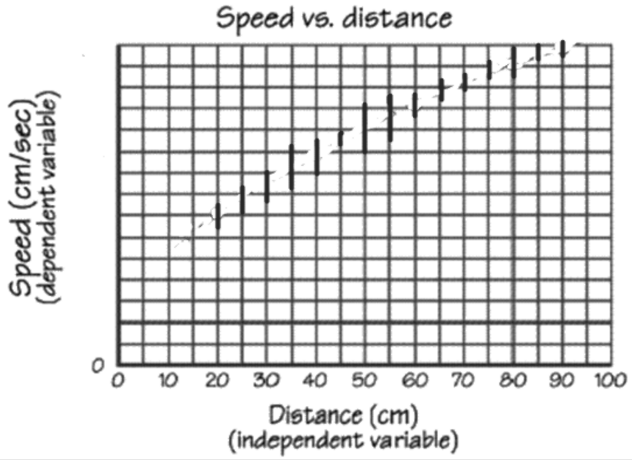


$$\text{Average speed for Part C} = \frac{15\text{ km}}{0.25\text{ hours}} = 60\text{ km/h}$$

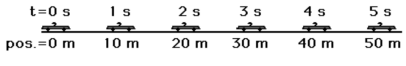
Try using the motion sensor to map your position over time

Lab 2.2 TIPS

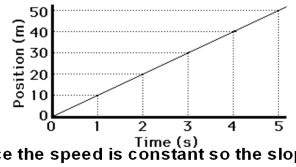
- Set up your ramp (pick a hole 5 through 9) and gates A and B.
- Put gate A at 10 cm
- Remember how turning off and on lights AB gave you different measurements? Today we will be using this to record time BETWEEN the gates (AB BOTH ON) and AT the gates (A ONLY for gate A, B ONLY for gate B).
- When calculating speed AT a gate use 5cm for distance



Consider the motion of a car moving at a constant 10m/s. From the ground the motion would look like this:

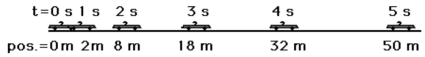


The graph of the position vs time would look like this

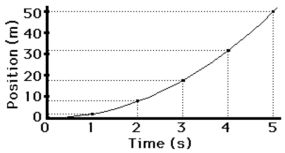


Notice the speed is constant so the slope is a straight line

Consider the motion of a car that is accelerating. The drawing of what it would look like from the ground would be:



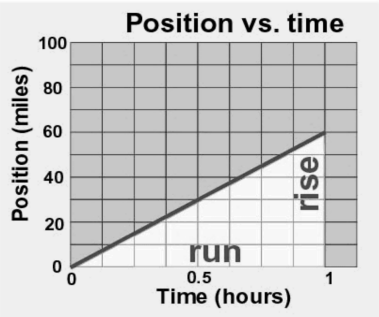
The graph of the position over time would look like this



Notice that in acceleration the speed is changing so the graph has a curved slope

Speed

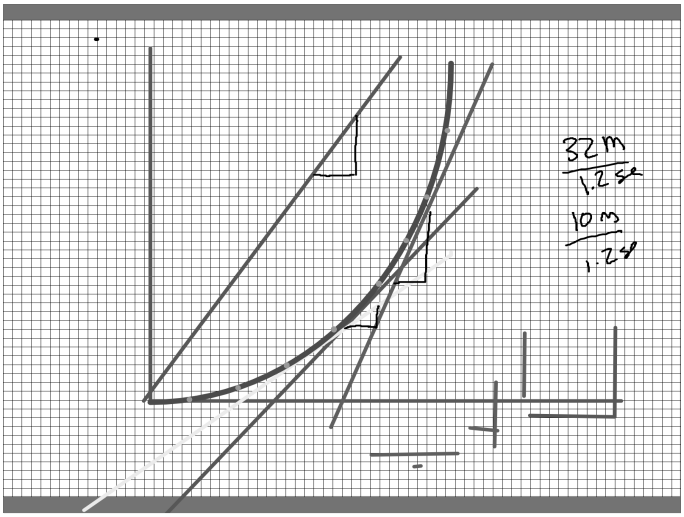
Speed is the slope of the position vs. time graph.



$$\text{Slope} = \frac{\text{rise}}{\text{run}}$$

$$= \frac{60 \text{ miles}}{1 \text{ hour}}$$

$$= 60 \text{ mph}$$



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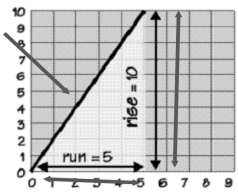
2.2 Determining Slope

- Slope is the ratio of "rise" (vertical change) to the "run" (horizontal change) of a line.
  - The rise is determined by finding the height of the triangle shown.
  - The run is determined by finding the length along the base of the triangle.

The slope of a graph



$$\text{Slope} = \frac{\text{rise}}{\text{run}} = \frac{10}{5} = 2.0$$

The slope of the line on a position-time graph reveals useful information about the velocity of the object.

"As the slope goes, so goes the velocity."

Whatever characteristics the velocity has, the slope will exhibit the same

- If the velocity is constant, then the slope is constant (i.e., a straight line).
- If the velocity is changing, then the slope is changing (i.e., a curved line).
- If the velocity is positive, then the slope is positive (i.e., moving upwards and to the right).

Tips for solving word problems

- How fast = velocity.
- How far = distance.
- How long= time
- How quickly how fast changes = acceleration

What is the velocity of a car that travels 450 km in 3.5 hours?

How far can a cheetah run in 30 minutes if it's top speed is 70 miles per hour?

$\frac{30\,min}{60\,min} = hr$

$d = v * t$

$70\,mi/hr \times .5\,hr =$

How long in hours will it take a runner to finish a marathon (27 miles) if she can run 1 mile in 6 minutes?

$60\,min = 1\,hr$

$10\,miles = 60\,min$

$10\,mile/hr \quad t = \frac{d}{v}$

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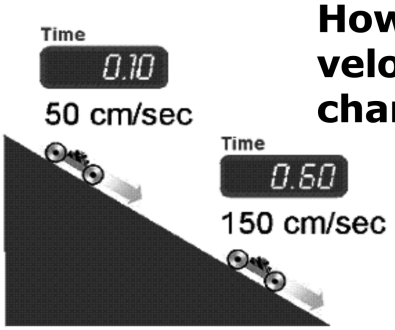
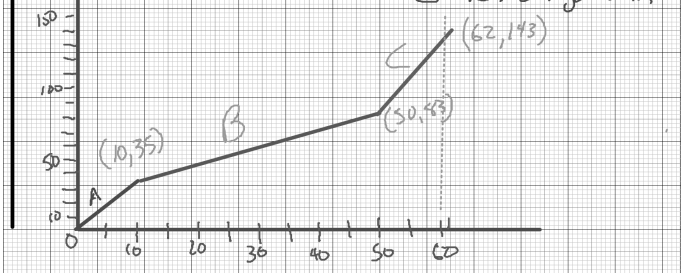
2.3 Acceleration

How is the velocity changing?

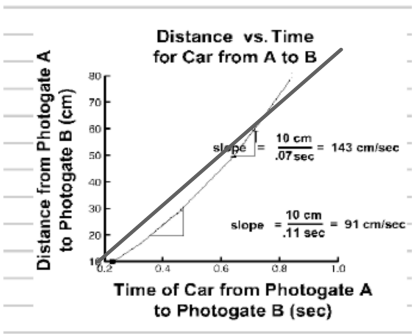


Average Speed Problems .

A 10 sec to go 35m
B 40 sec to go 48m
C 12 sec to go 60m



Speed of the car on the ramp



accel (5mi/hr)/s

Time	V (speed)
1	5 mi/hr
2	10 mi/hr
3	15 mi/hr
4	

How do we measure changes in velocity?

Acceleration: The rate at which the velocity of an object is changing.

- The term **acceleration** is typically used when the velocity increases.
- The term **deceleration** is typically used when the velocity decreases - another way of saying this is that deceleration is when negative acceleration is occurring.

Acceleration describes the change in velocity over a period of time.

$$a = \frac{V_{f\,(final)} - V_{i\,(initial)}}{T}$$

$$a = \frac{\Delta V}{\Delta T}$$

Δ means Change in

Units for acceleration:

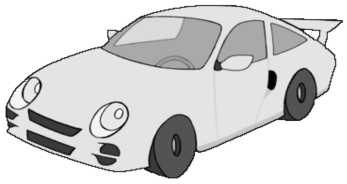
- Speed and velocity are easily measured in distance/time units, such as miles/hr, m/s, etc.
- Units of acceleration are more complicated, and have to take other stuff into account. Speed/time such as m/s/s, mi/hr/s

Let's take a look. m/s^2

Sample problem: What is the acceleration if we speed up from 10 km/h to 30 km/h in 10 seconds?

$$a = \frac{V_f - V_i}{T} \quad \frac{(30\ km/hr - 10\ km/hr)}{10\ sec} = \frac{20\ km/hr}{10\ sec} = 2\ km/hr/s$$

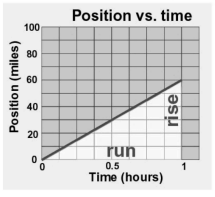
Virtual Car: Velocity and Acceleration



What are differences between speed and acceleration?

Speed

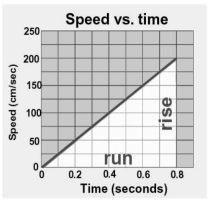
Speed is the slope of the position vs. time graph.



$$\text{Slope} = \frac{\text{rise}}{\text{run}} = \frac{60\ \text{miles}}{1\ \text{hour}} = 60\ \text{mph}$$

Acceleration

Acceleration is the slope of the speed vs. time graph.



$$\text{Slope} = \frac{\text{rise}}{\text{run}} = \frac{200\ \text{cm/sec}}{0.8\ \text{seconds}} = 250\ \text{cm/sec}^2$$

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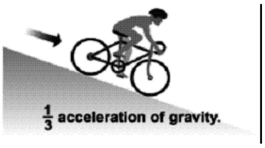
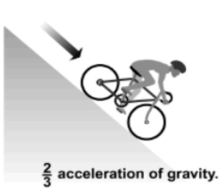
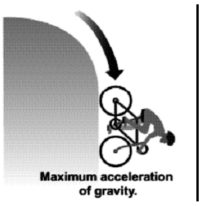




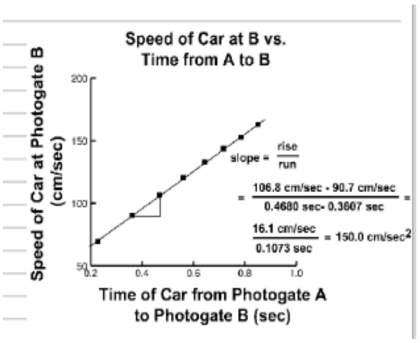


Lab 2.3
You will need to use data collected in lab 2.2 for the graph in part 2 of this lab.

x= time from A to B
y= speed at Gate B

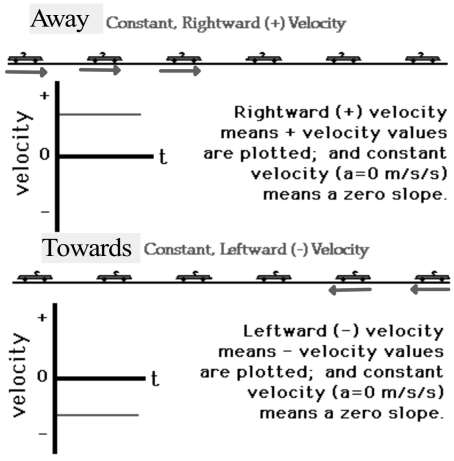
Acceleration = Speed B cm/s- Speed A cm/s
Time A to B in s

To find speed use distance of wing (5cm)
Speed at Gate = 5cm
Gate time in s



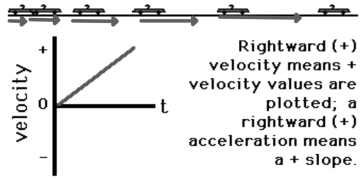
When can you have velocity but no acceleration?

When can you have acceleration but no velocity?



Horizontal slope means no change in velocity
NO Acceleration

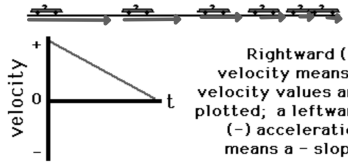
Rightward (+) Velocity with a Rightward (+) Acceleration speeding up



Rightward (+) velocity means + velocity values are plotted; a rightward (+) acceleration means a + slope.

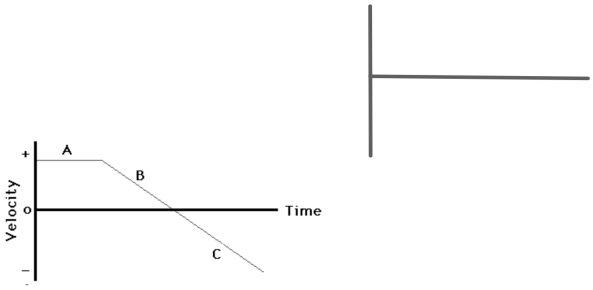
Angled slope means change in velocity YES Acceleration

Rightward (+) Velocity with a Leftward (-) Acceleration slowing down



Rightward (+) velocity means + velocity values are plotted; a leftward (–) acceleration means a – slope.

Describe the direction of motion, the velocity, acceleration and any changes in speed (speeding up or slowing down) during the various time intervals A, B, and C).



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2.3 Acceleration

Key Question:

How is the speed of the car changing?

*Read text section 2.3

BEFORE Investigation 2.3

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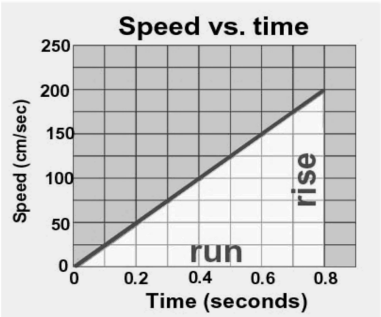
Chapter 2 Vocabulary Terms

- accelerate
- acceleration
- average speed
- conceptual model
- deceleration
- dependent variable
- free fall
- graphical model
- gravity
- independent variable
- physical model
- scientific model

Acceleration

Acceleration is the slope of the speed vs. time graph.



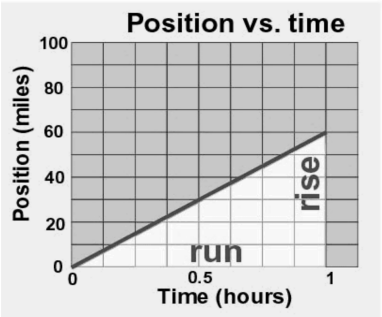
$$\text{Slope} = \frac{\text{rise}}{\text{run}}$$

$$= \frac{200 \text{ cm/sec}}{0.8 \text{ seconds}}$$

$$= 250 \text{ cm/sec}^2$$

Speed

Speed is the slope of the position vs. time graph.



$$\text{Slope} = \frac{\text{rise}}{\text{run}}$$

$$= \frac{60 \text{ miles}}{1 \text{ hour}}$$

$$= 60 \text{ mph}$$

Block 1

Group	Acceleration Trial 1	Acceleration Trial 2
SJSL	281.7 cm/s/s	262.6 cm/s/s
MS-DC-AM	266.0 cm/s/s	263.1 cm/s/s
em-fw	267.1 cm/s/s	268.4 cm/s/s
TS-AM-CJ	290.34 cm/s/s	268.13 cm/s/s
FJ-LN	259.0 cm/s/s	265.2 cm/s/s

$$\text{acceleration} = \frac{\text{Change in velocity}}{\text{Time}}$$

$$a = \frac{\text{Gate B speed} - \text{Gate A speed}}{\text{Time from A to B}}$$

$$V = \frac{d}{t} \leftarrow \frac{\text{wing width}}{\text{photogate}}$$